ORDNANCE MANAGEMENT ENGINEERING TRAINING AGENCY
SUMMARY OUTLINE - MATHEMATICAL PROGRAMMING

SESSION NO.	SUBJECT	TOPIC
1-1	I.	Orientation
		A. Information Forms
		B. Building 90 and RIA
		C. Quad City Area
	II.	Ordnance Management Engineering Training Agency
		A. History and Scope
		B. Curriculum
		C. Current FY Schedule
	III.	Operations Research
		A. Definitions
		B. History
1-2	I.	Models
		A. Types
		B. Inventory
		C. Waiting-Line
		D. Replacement and Maintenance
		E. Competitive
		F. Allocation
	II.	Allocation Problems
		A. Nature
		B. Methods of Solution
	III.	Introduction to Mathematical Programming
		A. Definitions
		B. Characteristics
		C. Brief Outlines of Successful Applications

1-2 (cont.) IV. Algebra Review

A. Notation
B. Elementary Operations

2-1 I. Transportation Problem

A. Type of Allocation Problem
B. Solutions
C. Calculation of "efficiency rates"

II. "Stepping Stone" Method

A. Initial Matrix
B. Evaluation of Water Squares
C. Interpretation of Water Values
D. Improving the Solution
E. Work Session

2-2 I. The Modified Distribution Method (MODI)

A. Similarity to "Stepping Stone" Method
B. Matrix Form
C. Procedure
D. Work Session

3-1 I. Variations in the Matrix

A. Demand Exceeds Capacity
B. Capacity Exceeds Demand
C. Impossible Conditions
D. Work Session

II. Degeneracy

A. Initial Allocation
B. Intermediate Solutions
C. Corrective Action on a Degenerate Matrix

MATH PROGRAMMING (Summary Outline)

3-2

I. Alternate Solutions

- A. Optimum Solutions
- B. Near-Optimum Solutions

II. Vogel's Approximation Method (VAM)

- A. Value of the VAM
- B. Method of Solution
- C. Auxiliary Rules
- D. Work Session

4-1

I. Multi-Dimensional Distribution Problems

- A. The Nature of the Problem
- B. Methods of Solution

4-2

I. Work Session (Multi-Dimensional Problems)

5-1

I. The Assignment Problem

- A. Introduction
- B. The Mathematical Model
- C. Flood's Method of Solution
- D. Hungarian Method
- E. VAM Solution
- F. Variations
- G. Work Session

5-2

I. Systems of Linear Equations

- A. Methods of Solution
- B. Programming Restrictions

II. Matrix Algebra

- A. Matrix Notation
- B. Matrix Operations
- C. Mathematical Models
- D. Work Session

MATH PROGRAMMING (Summary Outline)

6-1

I. The Simplex Formulation

- A. Introduction
- B. Algebraic Expression of Relationships Involved
- C. The Simplex Matrix

II. The Simplex Algorithm

- A. Illustrate Steps in Solution
- B. Example (Simplex Algorithm, 6-1)

6-2

I. The Simplex

- A. Solution
- B. Interpulation
- C. Alternate Solutions
- D. Computational Simplifications

7-1

I. Work Session (Blending Problem)

- A. Formulation
- B. Solution

7-2

I. Graphic Representation of the Simplex

- A. Graphic Analysis
- B. Graphic Solution

II. Work Session

8-1

I. Variations in the Simplex

- A. Opportunity Profits
- B. Degeneracy

II. Sequential Approach to Formulation

MATH PROGRAMMING (Summary Outline)

8-2 I. Work Session (Product-Mix)

A. Formulation
B. Solution

9-1 I. Objective Functions

A. Maximum Profit Program
B. Maximum Production Program
C. Maximum Utilization Program
D. Maximum Customer Delivery

9-2 I. Computer Programs

A. Simplex
B. LGP-30

II. Work Session

A. Setting up previous problems in computer format
B. Solution on LGP-30
C. Interpretation of results

10-1 I. Examination

10-2 I. Examination

11-1 I. Relation of Simplex to Distribution

A. Formulating the Distribution into the Simplex
B. Reducing the Simplex to a Distribution Matrix

11-2 I. Relaxation Methods

A. Types of Problems Adaptable to Relaxation
B. Techniques Involved
C. Representative Formats

MATH PROGRAMMING (Summary Outline)

12-1 I. Machine Allocation Problems

- A. Formulation
- B. Index Method of Solution
- C. VAM Solution

12-2 I. Work Session (Machine Allocation)

- A. Formulation
- B. Approach to Solution

13-1 I. Correlation Type Problems

- A. Isolation of Pertinent Variables
- B. Minimizing Slack Variability

II. Work Session

13-2 I. Class Projects

- A. Assignments
- B. Project Work Session

14-1 I. Presentation of Projects

II. Basic Inventory Models

14-2 I. Waiting-Line Models

II. Simulation

15-1 I. Replacement Models

II. Competitive Models

III. Summary

IV. Graduation

DISTRIBUTION TYPE PROBLEM

Items to be Rebuilt are stored at:

	Units
Ft. Lewis	150
Ft. Bragg	40
Ft. Cambell	80
	270

Rebuild Centers	Productive Capacity Units
Red River	90
Benôsa	70
Rock Island	50
Anniston	60
	270

Shipping costs per unit

From/To	R.R.	Benecia	R.I.	Anniston
Ft.Lewis	22.00	13.00	16.00	49.00
Ft.Bragg	5.00	35.00	25.00	12.00
Ft.Campbell	25.00	44.00	20.00	37.00
Rebuild Cost	5.00	10.00	15.00	20.00

Seven equations 1 objective function

TO / FROM	RR 1	B 2	RI 3	AN 4	
Ft. L X	X_1	X_2	X_3	X_4	150
Ft B Y	Y_1	Y_2	Y_3	Y_4	40
Ft C. Z	Z_1	Z_2	Z_3	Z_4	80
	90	70	50	60	

A chemical company has a series of high-pressure injection pumps operating under similar conditions and wishes to determine a proper maintance policy.
Each pump has 3 intake and 3 exhaust valves. When a valve fails, it is necessary to shut down the pump and prepare it for maintance. Each set of valves is covered by a manifold which must be removed after shutdown in order to expose either the three intake or three exhaust valves. There is no down-time costs as the firm has stand-by pumps to be used during maintenance on the valves.

The company wants to evaluate the following maintancy policies:

I) Repair a valve only when it fails
II) Repair all three exhaust valves if one exhaust valve fail, or all three intake valves if one intake valve fails
III) Repair all six valves whenever a pump must be shut down to repair one valve.

IV) Repair the valve that fails plus all valves which have been in use more than the expected service life.

The company supplied the following data:

operation	Time (hrs)
Shutdown, prepare for maintenance	1/2
Remove manifold (either intake or exhaust)	2/3
Disassemble one valve	1/3
Overhaul one valve	1 1/4
Assemble one valve	1/3
Replace one manifold (either intake or exhaust)	2/3

The probability distribution of service life

Valve age at failure (hours)	Probability
100	.10
200	.10
300	.15
400	.10
500	.08
600	.04
700	.10
800	.08
900	.06
1000	.05
1100	.04
1200	.03
1300	.03
1400	.02
1500	.02
~~1600~~	~~.01~~
~~1700~~	~~.01~~

100

A manufacturer wishes to determine how to produce two products (A and B) so as to realize the max total profit. Both products are made in two processes (I & II). It takes 7 hours in I and 4 hrs in II to mfg 100 units of product A. It requires 6 hrs in I & 2 hrs in II to mfg 100 units of B.

Process I can handle 84 hrs of work, and process II can take 32 hrs.

Profit for A is $11.00/100 units

Profit for B is $4.00/100 units.

It is assumed that whatever is produced can be sold.